



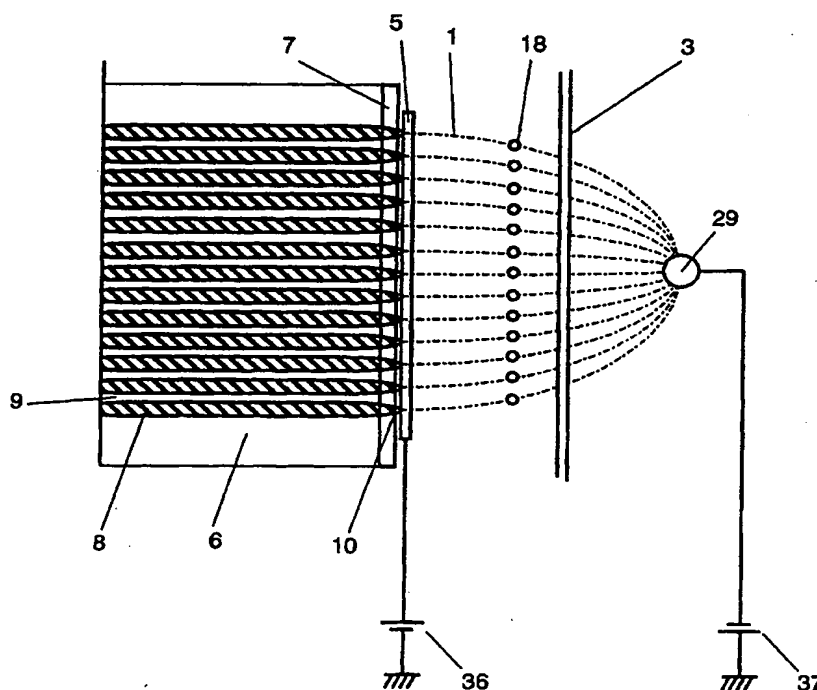
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : B41J 2/09, 2/095	A1	(11) International Publication Number: WO 00/38930
		(43) International Publication Date: 6 July 2000 (06.07.00)
<p>(21) International Application Number: PCT/JP99/07217</p> <p>(22) International Filing Date: 22 December 1999 (22.12.99)</p> <p>(30) Priority Data: 10/369169 25 December 1998 (25.12.98) JP</p> <p>(71) Applicant (for all designated States except US): MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD. [JP/JP]; 1006, Oaza Kadoma, Kadoma-shi, Osaka 571-8501 (JP).</p> <p>(72) Inventors; and (75) Inventors/Applicants (for US only): MATSUI, Masatomo [JP/JP]; 554-5, Oomachi, Saijo-shi, Ehime 793-0030 (JP). BANDO, Katsuhiko [JP/JP]; 1727-2, Hagyu, Niihama-shi, Ehime 792-0050 (JP). KOUYAMA, Yoshihisa [JP/JP]; 518-5, Kitadai, Toyo-shi, Ehime 799-1343 (JP). SONE, Koji [JP/JP]; 1942-33, Oojoin, Niihama-shi, Ehime 792-0060 (JP). SEO, Naoyuki [JP/JP]; 813-1, Oomachi, Saijo-shi, Ehime 793-0030 (JP).</p> <p>(74) Agents: IWAHASHI, Fumio et al.; Matsushita Electric Industrial Co., Ltd., 1006, Oaza Kadoma, Kadoma-shi, Osaka 571-8501 (JP).</p>		<p>(81) Designated States: CN, ID, KR, SG, US.</p> <p>Published With international search report.</p>

(54) Title: INK JET RECORDING APPARATUS

(57) Abstract

The present invention relates to an ink jet recording apparatus that prints by ejecting ink onto recording media. The ink jet recording apparatus achieves high density recording on the recording media without narrowing the pitch of nozzle holes. The ink jet recording apparatus charges sprayed ink drops by a charging electrode (5), applies a high voltage on a deflecting electrode (29) placed in a position facing the center of a plurality of nozzle holes (10) disposed in a line, and controls flying paths of the ink drops (18). The ink drops are electrostatically deflected by the high voltage, fly through the flying path converging toward the deflecting electrode, and reach to the recording face. Thus, the ink jet recording apparatus which achieves high density recording can be provided without using narrow pitch nozzle holes, which requires a difficult machining process and is difficult to manufacture.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

DESCRIPTION

INK JET RECORDING APPARATUS

5

FIELD OF THE INVENTION

The present invention relates to an ink jet recording apparatus that achieves high density recording by spraying ink from a plurality of nozzle holes to enhance the concentration of ink drops on recording media such as paper and plastics.

BACKGROUND OF THE INVENTION

As a head for a conventional ink jet recording apparatus, thermal ink jet heads, piezoelectric transducer-type ink jet heads which use piezoelectric elements, and sound-wave-controlled ink jet head have been commercialized. Fig. 4 shows a perspective view of the main parts of ink jet recording apparatus using a piezoelectric transducer-type ink jet head.

In Fig. 4, a nozzle plate 7 is disposed on part of an actuator 6. On one side of the actuator 6 are a plurality of parallel bulkheads 6 made from piezoelectric ceramic, and which extend toward the nozzle plate 7. The bulkhead 6 has a plurality of ink channels 8. Sizes of the actuator 6 and bulkheads 9 need to be very precise. Therefore, they are integrally formed with the same piezoelectric ceramics material. On the nozzle plate 7 are a plurality of nozzle holes 10 correspondingly made with the channels 8 at

regular intervals on a line.

An actuator cover 14 is made from a ceramics material or a plastic material. The actuator cover 14 is formed such that along with the actuator 6, it sandwiches the bulkheads 9. From a ink supply hole 13 ink is supplied
5 to the channels 8 formed on part of the actuator cover. The manifold 17 supplies ink sent from an ink container (not illustrated) to the channels 8 evenly. The ink jet head is constructed as described above.

Signal electrodes 11 are formed by sputtering or vapor deposition on part of the actuator-cover side bulkheads 9. A printed circuit board 12 is
10 connected to a voltage generating circuit (not illustrated) which generates voltage that changes voltage into pressure.

Terminal electrodes 15 are disposed on the printed circuit board 12. A bonding wire 16 supplies voltage to the signal electrodes 11 via the terminal electrodes 15.

15 The bulkheads 9 are polarized in the depth direction of the grooves, and are deformed depending on the amount of applied voltage on the signal electrodes 11. Along with the deformation, ink filling the channels 8 is sprayed selectively from the nozzle holes 10 which are connected to the channels 8.

20 Fig. 5 shows a plan view illustrating a main part of a conventional ink jet head. In Fig. 5, ink drops 18 are sprayed from the nozzle holes 10. The ink drops 18 are sprayed at regular intervals, fly along paths 1 and parallel to one another and reach onto recording media 3.

With the conventional construction mentioned above, the pitch of
25 the nozzle holes determines flying paths of the ink drops, and the ink drops

reach onto the recording media along the flying paths. In other words, the pitch of the nozzle holes determines the resolution of recording. In order to enhance the resolution, the pitch of the nozzle holes must be narrowed. However, machining of the bulkheads and the channels is difficult, since they
5 are made of piezoelectric ceramic, and machining requires a blade using diamond abrasive. Thus, a density of the recording is limited with the ink jet head with the conventional construction.

DISCLOSURE OF THE INVENTION

10

The ink jet recording apparatus of the present invention has a deflecting electrode for deflecting the pitch of ink jet drops sprayed from the nozzle holes. The ink jet recording apparatus also includes charging means for charging the ink drops. The deflecting electrode and nozzle holes move
15 maintaining their positions relative to each other. The deflecting electrode is disposed on the ink jet head facing the back of the recording face of the recording media.

With the construction disclosed in the present invention, pitch between the ink drops reaching onto the recording media can be narrowed
20 without decreasing the pitch and sizes of the nozzle holes of the ink jet head. Thus high-density recording becomes possible.

BRIEF DESCRIPTION OF THE DRAWINGS

25

Fig. 1A shows a front view of the main part of ink jet recording

apparatus of a preferred embodiment of the present invention;

Fig. 1B shows a side view of elements of the ink jet head;

Fig. 2 shows a plan view illustrating the flight paths of the ink drops ejected from the ink jet head of the ink jet recording apparatus of the present invention;

Fig. 3 shows a perspective view of the ink jet head of the ink jet recording apparatus of the present invention;

Fig. 4 shows a perspective view of the ink jet head of the prior art ink jet recording apparatus; and

Fig. 5 shows a plan view illustrating the ink drops ejected from the ink jet head of the prior art ink jet recording apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The ink jet recording apparatus of the present invention includes the following elements:

a) an ink jet head with a plurality of nozzle holes, and which moves transversely to the delivering direction of the recording media;

b) a deflecting electrode for deflecting ink drops sprayed from the nozzle holes, and which maintain relative positions with the nozzle holes; and

c) a high voltage generator for applying high voltage to the deflecting electrode.

And, the deflecting electrode is disposed on the ink jet head facing to the back of the recording face of the recording media.

The ink jet recording apparatus of the present invention has a

charging electrode near the nozzle holes for charging the ink drops if necessary, and a charging voltage generation means for applying voltage to the charging electrode.

The construction of the ink jet recording apparatus of the present invention allows narrowing the pitch of the ink drops reaching onto the recording media, thereby achieving a high density recording.

Secure and stable narrowing of the pitch of the sprayed ink drops onto the recording media becomes possible by charging the sprayed ink drops, thus achieving a high density recording.

Further, since the deflecting electrode is disposed on the ink jet head facing the back of the recording face of the recording media, the deflecting electrode needs not to be disposed in the limited small space between the ink jet head and the recording media. Due to this disposition, the deflecting electrode does not obstruct the flying paths of the ink drops, thus allowing the deflecting electrode to be disposed at the optimal positions.

First preferred embodiment

The preferred embodiments of the present invention are described below with reference to Fig. 1 and Fig. 3. In the Figs, the parts which have the same function as those of the prior art carry the same numbers.

Fig. 1A shows a front view of the main part of ink jet recording apparatus of a preferred embodiment of the present invention.

In Fig. 1A, a motor 21 rotates a feed screw A 25 via a gear A 22 and a gear B 23 which engages the gear A 22. A feed screw B 26 cut inversely to a feed screw A 25 rotates combined with a gear C 24. With this construction an

ink jet head 20 and its mounting board 30 are formed such that their relative positions are maintained fixed all the time. A rotating shaft 28 is a rotation centers of the feed screw A 25 and the feed screw B 26. A round-shaped electrode 29 is placed in a position facing approximately the center of a plurality of nozzle holes (described later) disposed in a line.

The mounting board 30 holds the deflecting electrode 29. A guide 31 prevents flexure of the recording media 3. The feed screws A 25 and B 26 are placed parallel to each other. They are maintained such that they can rotate around the rotating shafts 28 that are supported by a frame 32.

In between an ink jet head 20 and the deflecting electrode 29 is the recording media 3 which is maintained by a platen roller 35. The platen roller 35 delivers the recording media 3. The ink jet head 20 and the mounting board 30 are driven together while their relative positions fixed by the feed screws A 25 and B 26. Therefore, relative positions of the deflecting electrode 29 and the nozzle holes are constantly maintained.

A charging voltage generation means 36 generates charging voltage to be applied to a charging electrode (described later). A deflecting voltage generation means 37 applies high negative voltage to the deflecting electrode 29.

Fig. 1B shows a side view of elements of the ink jet head.

In Fig. 1B, an engaging section A 33 is disposed on the feed screw A 25 side of the ink jet head 20 and engages with valleys of the feed screw A 25. And, the engaging section A 33 sends the ink jet head 20 transversely to the delivering direction of the recording media 3 when the motor 21 rotates.

An engaging section B 34 is disposed on the feed screw B 26 side of

the mounting board 30 and engages with valleys of the feed screw B 26. And, the engaging section B 34 sends the mounting board 30 transversely to the delivering direction of the recording media 3 when the motor 21 rotates. In other words, the above-mentioned construction allows the ink jet head 20 and the deflecting electrode 29 to move transversely to the delivering direction of the recording media 3 by the motor 21.

Fig. 2 shows a plan view illustrating the ink drops ejected from the ink jet head of the ink jet recording apparatus.

In Fig. 2, a charging electrode 5 positively charges ink drops 18 sprayed from nozzle holes 10 as they pass through the charging electrode 5. The charging voltage generation means 36 illustrated in Fig. 1 applies voltage to the charging electrode 5.

The round-shaped electrode 29 is applied with high negative voltage by the charging voltage generation means 37.

In Fig. 2 and Fig. 3, the box-shaped charging electrode 5 surrounding all the nozzle holes 10 is hollow inside so that the ink drops 18 can pass through.

After ejected, the ink drops 18 are positively charged by the charging electrode 5, and electrostatically deflected by a high negative voltage between minus one thousands and minus several thousands of the deflecting electrode 29. If the surface of the recording media 3 is negatively charged and the potential of a round-shaped deflecting electrode 4 is low due to the deflecting electrode 29, neutralization occurs when the ink drops 18 are sprayed onto the recording media 3. As a result, electric force lines are changed leaving an insufficient deflection. In order to prevent such

neutralizing effect, the potential of the deflecting electrode 4 should be desirably set between minus one thousands and minus several thousands.

Any kind of conventional high voltage generator can be used for the deflecting voltage generation means 37. As the deflecting voltage generation means 37 simply provides an electric field, and does not require a large electric current, even a light weight and compact device such as a piezoelectric transformer can be used as the deflecting voltage generation means 37.

With the foregoing construction, the ink drops 18 reach the recording face of the recording media 3 via the flying paths 1 which converge into one spot toward the deflecting electrode 29 as illustrated in Fig. 2.

In other words, according to the ink jet recording apparatus of the present invention, intervals of the ink drops 18, namely the recording density, can be changed, while maintaining the pitch of the nozzle holes 10 constant, by changing the relative distance between the nozzle holes 10, the recording media 3 and the deflecting electrode 29.

By including the deflecting electrode 29 and charging the ink drops 18, recording density on the recording media can be enhanced. A difficult machining of the ink jet head can be avoided. Thus, the recording density that has been conventionally determined by the pitch of the nozzle holes can be enhanced at remarkably low cost.

In the foregoing description, the charging electrode 5 is a hollow box-shaped, however, the charging electrode 5 can be in any shape providing it charges and allows the ink drops 18 to pass through inside.

Other possible charging means include corona charging, which can be utilized by introducing a metal mesh or fine metal lines applied by a high

voltage near the nozzle holes 10. Blowing ion wind generated by an ion generating device near the nozzle holes 10 is another possible method.

By utilizing highly insulating materials such as plastics and ceramics materials for the nozzle plate 7, and mixing charging controlling materials such as metal soaps with ink, ink drops can be charged just by being
5 ejecting from the nozzle.

A conductive materials can also be used for the nozzle plate and make the potential of the ink drops 18 zero. In this case, a charging voltage generation means 36 for the charging electrode is not necessary.

10 In the foregoing description, the ink drops 18 are positively charged, and the deflecting electrode negatively charged with high voltage. However, negatively charged voltage and positively charged high voltage can be applied to the charging electrode and deflecting electrode respectively.

The ink jet head 20 and the mounting board 30 are driven by the
15 same motor 21 in the description mentioned above. However, they can be driven by different motors. The ink jet head 20 and the mounting board 30 can be integrally formed.

INDUSTRIAL APPLICABILITY

20 The ink jet recording apparatus of the present invention converges the ink drops toward the deflecting electrode by utilizing the ink jet head comprising the ink ejection heads, the charging electrode and the deflecting electrode. If necessary, the ink drops can be charged by charging means. With the construction of the present invention, recording density of the ink jet
25 recording apparatus can be enhanced. As the ink jet recording apparatus of

the present invention accelerates the ink drops charged by the charging means, an influence caused by the change in environmental factors such as air flow and temperature near the recording apparatus on the ink can be restricted. Thus, printing of even higher precision can be made possible.

5 As have been described, according to the present invention, an ink jet recording apparatus which realize high recording density at low cost can be provided. Thus, significant industrial benefits can be expected.

CLAIMS

1. An ink jet recording apparatus comprising:

- a) an ink jet head with a plurality of nozzle holes, and which
5 moves transversely to a delivering direction of a recording medium;
- b) a deflecting electrode for deflecting ink drops ejected from
the nozzle holes, and which moves maintaining relative positions with the
nozzle holes; and
- c) a high voltage generator for applying a high voltage to the
10 deflecting electrode.

2. An ink jet recording apparatus comprising:

- a) an ink jet head with a plurality of nozzle holes, and which
moves transversely to a delivering direction of a recording media;
- 15 b) a charger for charging ink drops ejected from the ink
nozzles;
- c) a deflecting electrode for deflecting the ink drops, and which
moves maintaining relative positions with the nozzle holes; and
- d) a high voltage generator for applying high voltage on the
20 deflecting electrode.

3. The ink jet recording apparatus of claim 1 or claim 2, wherein the
deflecting electrode is disposed on a position facing a back surface of a
recording surface of the recording medium.

FIG. 1A

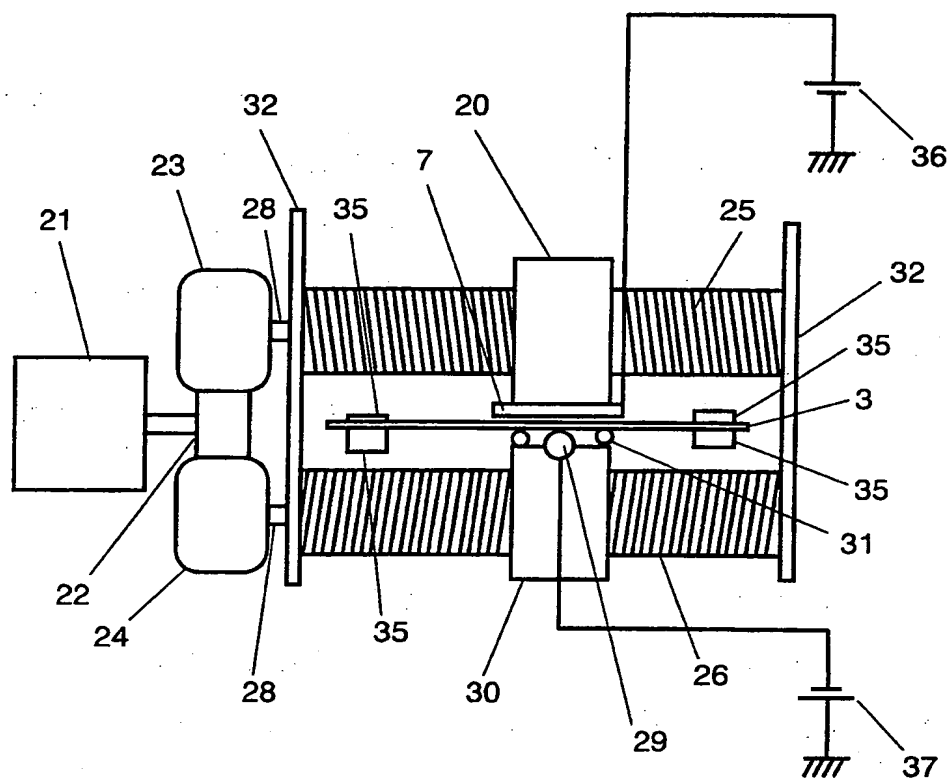


FIG. 1B

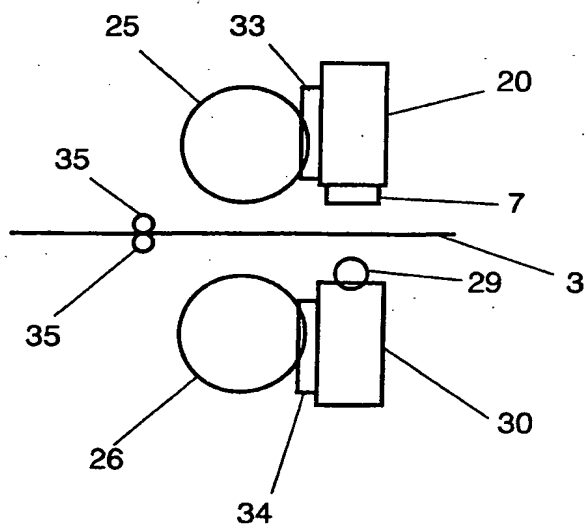


FIG. 2

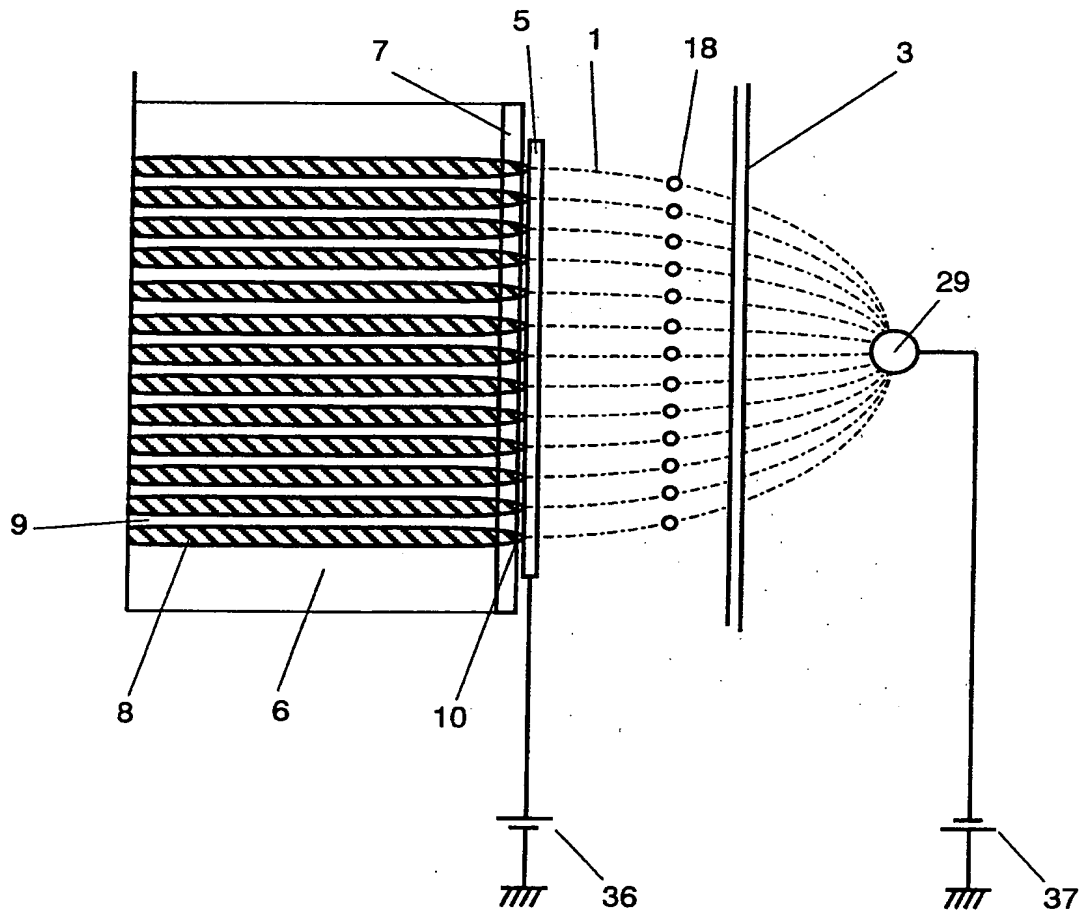


FIG. 3

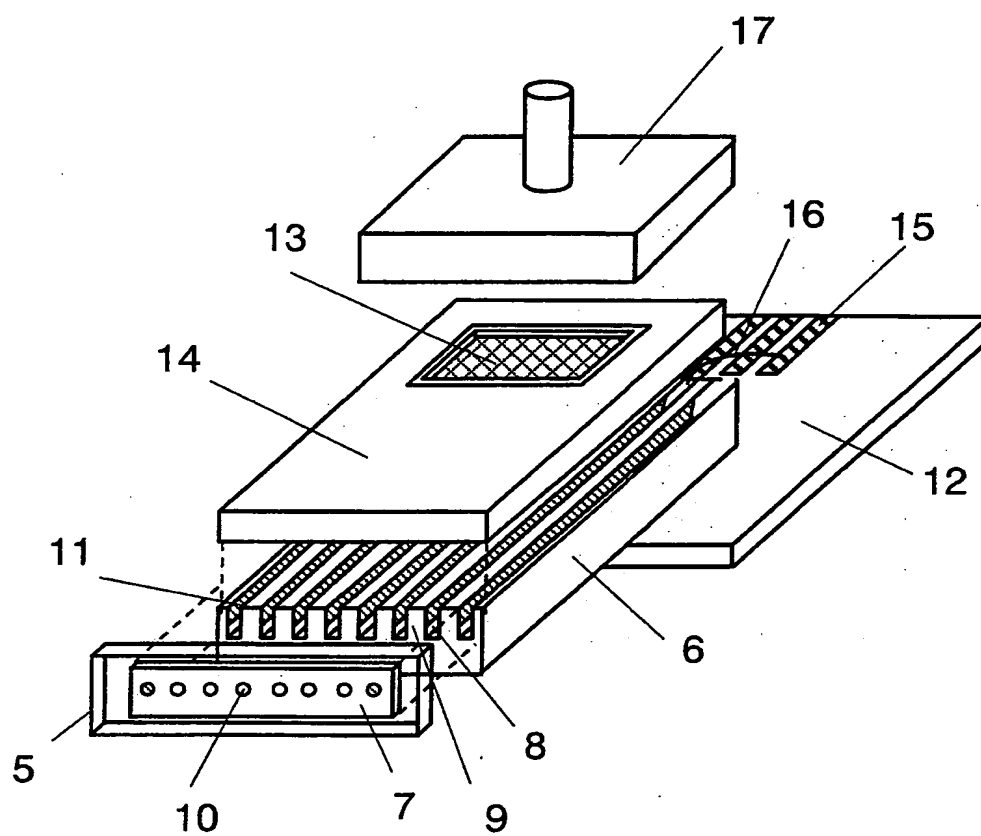


FIG. 4

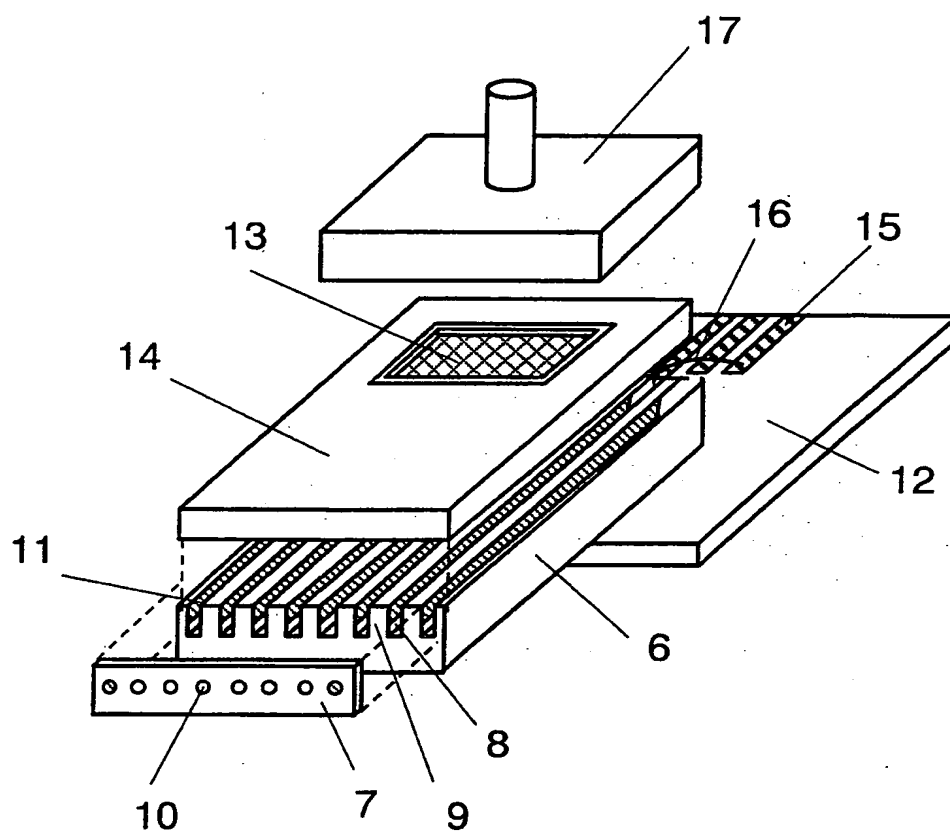
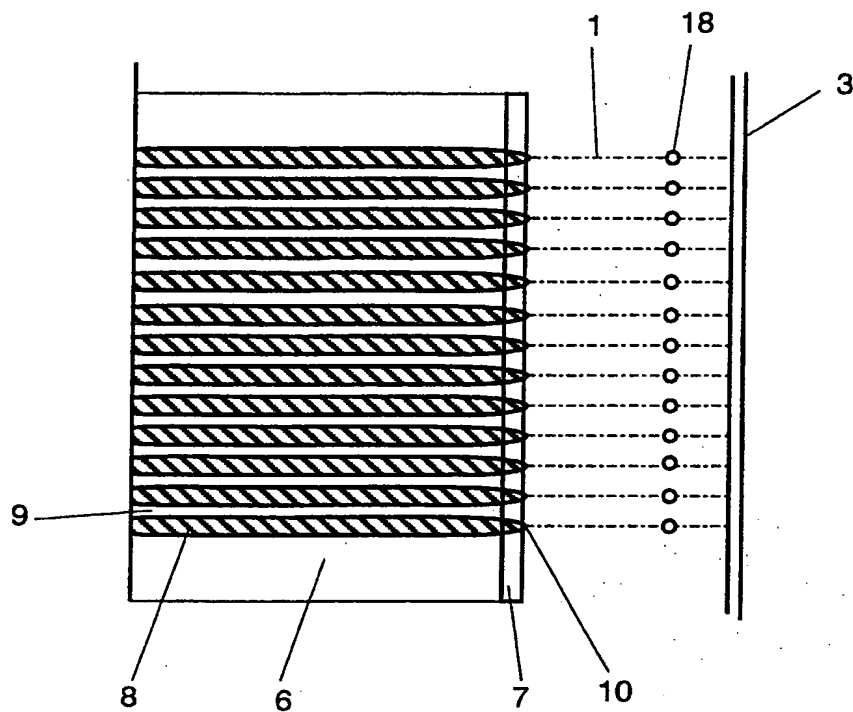


FIG. 5



Reference Numerals

1. Flight path
3. Recording medium
4. Deflecting electrode
5. Charging electrode
6. Actuator
7. Nozzle plate
8. Channel
9. Wall
10. Nozzle hole
11. Signal electrode
12. Printed circuit board
13. Ink supply hole
14. Actuator cover
15. Terminal
16. Bonding wire
17. Manifold
18. Ink drop
20. Ink jet head
21. Motor
22. Gear A
23. Gear B
24. Gear C
25. Feed screw A
26. Feed screw B
28. Rotating shaft
29. Deflecting electrode
30. Mounting board
31. Guide
32. Flame
33. Engaging section A
34. Engaging section B
35. Platen roll
36. Charging voltage generator
37. Deflecting voltage generator

INTERNATIONAL SEARCH REPORT

International Application No

PCT/JP 99/07217

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B41J2/09 B41J2/095

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B41J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 07, 31 July 1997 (1997-07-31) & JP 09 057980 A (MATSUSHITA ELECTRIC IND CO LTD), 4 March 1997 (1997-03-04) abstract	1,2
A	US 4 851 860 A (MUTOH MASAYUKI) 25 July 1989 (1989-07-25) column 4, line 32 - line 49 claim 1; figure 5	1,2
A	EP 0 780 231 A (DOMINO PRINTING SCIENCES PLC) 25 June 1997 (1997-06-25) abstract	1,2

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

10 April 2000

Date of mailing of the international search report

18/04/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Wehr, W

INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

PCT/JP 99/07217

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 09057980 A	04-03-1997	NONE	
US 4851860 A	25-07-1989	JP 62225363 A	03-10-1987
EP 0780231 A	25-06-1997	DE 69605013 D	09-12-1999
		DE 69605013 T	24-02-2000
		JP 9183227 A	15-07-1997
		US 5943077 A	24-08-1999
		US 5808642 A	15-09-1998